BULLETIN

OF THE INSTITUTE OF METALS

VOLUME 2 JULY 1954 PART 11

INSTITUTE NEWS

Autumn Meeting, Switzerland, 6–14 September 1954

As previously announced, the 1954 Autumn Meeting will be held in Switzerland, by invitation of the Société Suisse des Constructeurs de Machines and the Association Suisse pour l'Essai des Matériaux. The meeting will open in Zürich on Monday, 6 September, and members and ladies will leave Zürich by special train on Saturday, 11 September for Montreux, from which town additional visits to works will be paid until the afternoon of Tuesday, 14 September, inclusive.

The programme of the meeting is detailed below. All members of the Institute resident in Europe will receive separately a programme and Reply Form for completion; others who wish to take part in the meeting are requested to apply for copies.

Evening dress will *not* be required at any of the social functions arranged in connection with the meeting.

As it is not practicable for a large number of members and ladies to travel by sleeper to and from Zürich on the same day unless special arrangements are made, the Council has arranged that Thos. Cook and Son, Ltd., shall act as agents for travel, accommodation, and certain other services. Members are, however, free to make their own travel and hotel arrangements, if they so desire, but in that event they will be required to pay to the Secretary's Office, in Swiss francs, the Meeting Registration Fee and an inclusive charge for transport to works and other visits, etc., when they register in Zürich.

Those who wish to take advantage of the services of the agents are requested (*a*) to apply, *at the earliest possible moment* (quoting ref. POD/S/22222), to the Post-Order Department, Thos. Cook and Son, Ltd., Berkeley Street, London, W.1 (telephone GRO 4000, Extension 587) for particulars of travel and hotel accommodation and to note that the reservation of rooms cannot be guaranteed after 31 July; and (*b*) to ensure that, when making their bookings, they are quite clear what services, meals, &c. are being contracted for.

As the programme shows, on certain days lunch and dinner will be taken, by invitation or otherwise, elsewhere than at members' hotels. On other days, these meals must be paid for in Swiss francs, whether ordered privately at a restaurant or at the hotels, through the travel agents.

Hotels in Zürich have declined to reserve accommodation on a bed-and-breakfast basis, and require that, during the period of stay in Zürich, not less than four main meals (lunch or dinner) be included; in consequence, Thos. Cook and Son, Ltd., will quote for travel, handling of baggage, bed and breakfast, and four main meals in Zürich, and on a bed-and-breakfast basis in Montreux. Experience has shown that, with very few exceptions, members prefer to stay at either First-Class, Superior Second Class, or Ordinary Second Class hotels; in consequence, the agents have been asked to quote for such hotels only in the documents that they will send to those who apply for them, and the administrative arrangements are simplified if members will restrict themselves to one of these three classes throughout. The agents will be prepared, however, to quote for other requirements if requested to do so.

Thos. Cook and Son, Ltd., have authority to collect from members and ladies, on behalf of the Institute, *in Swiss francs*, the registration fees in connection with the meeting and charges for local travel and other expenses that will be incurred by the Institute in Switzerland on behalf of members.

Members are reminded that the duties of the Institute's staff must be restricted to the actual details of the meeting programme; on matters relating to travel and accommodation members are requested to deal only with the representatives of Thos. Cook and Son, Ltd., or to be entirely responsible for making their own private arrangements. Members who are making their own travel and hotel arrangements but who wish to travel from Zürich to Montreux by the special train, must buy the railway tickets for that journey from Thos. Cook and Son, Ltd., and make arrangements for the transfer of their luggage, at the agents' Zürich office.

Descriptions of works, laboratories, &c., to be visited will be included in the programme that will be posted separately to all members.

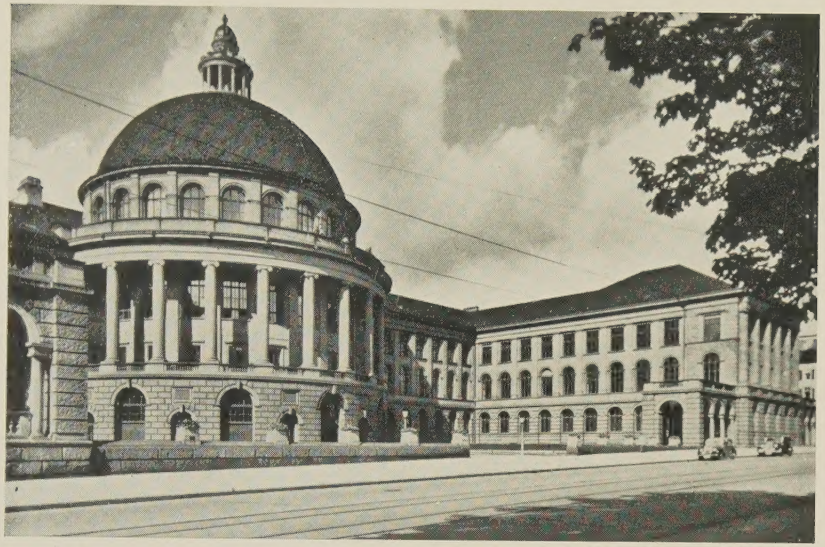
Members are entitled to attend all scientific sessions of the meeting without charge. Participation in visits and social functions, however, will be strictly reserved to those who have formally registered for the meeting and paid the meeting Registration Fee in Swiss francs before being issued with their meeting tickets and literature.

The Council hopes that there will be a large attendance at this meeting, for which the Institute's hosts have arranged a most attractive programme and generous hospitality.

Executive Committee

The following Swiss Executive Committee is responsible for the arrangements made for the meeting:

Professor Dr. A. von Zeerleder, *Chairman.*
Professor Dr. E. Brandenberger.
Dr. O. H. C. Messner.
Mr. W. von Orelli, *Honorary Secretary.*



[E. Fur.er

Eidgenössische Technische Hochschule, Zürich, where the meetings will take place.

[E. Furter

Schipfe, Zürich.

Limmatquai and Grossmünster Zürich.

B. Fransioli

Castle of Chillon, near Montreux.

PROGRAMME

Saturday, 4 September

P.m. Main party of British members and ladies leaves London, with couriers, under arrangements made by Thos. Cook and Son, Ltd.

Sunday, 5 September

8.10 a.m. Main party of British members and ladies arrives in Zürich.

All day Free in Zürich.

The Secretary's Office will be open, at a time and place which will be printed on the Registration Tickets, for the Registration of members and guests and the issue of tickets, badges, &c.

Monday, 6 September

Location : Eidgenössische Technische Hochschule, Zürich.

9.0 a.m. to 5.0 p.m. The Secretary's office will be open for the Registration of members and their guests and the issue of tickets, badges, and literature.

9.30 a.m. *Opening Session.* Speeches of welcome.

9.50 a.m. *Presentation of 1953 Institute of Metals (Platinum) Medal* to Professor Dr. Georg Masing.

10.15 a.m. *Discussion on the Theme : Grain-Refinement,* based on the following two papers published in the *Journal :*

(i) " The Application of Grain-Refinement to Cast Copper–Aluminium Alloys Containing the Beta Phase ", by J. P. Dennison and E. V. Tull (Serial No. 1472; July, 1953).

(ii) " Grain-Refining Additions for Cast Copper Alloys ", by A. Cibula (Serial No. 1549; July, 1954).

12.30 p.m. Adjournment. Depart by motor coaches from the E.T.H. to the Kongresshaus.

1.0 p.m. *Lunch* at the Kongresshaus, Gartensaal.

VISITS

2.15 p.m. promptly A.—VISITS FOR MEMBERS WHO HAVE REGISTERED FOR THE MEETING (ticket-holders only), by invitation, to one of the following. Motor coaches will depart from the Kongresshaus. (The total numbers for each visit are strictly limited.)

(1) *Swiss Car and Elevator Manufacturing Corporation, Ltd.*, Schlieren-Zürich. (Manufacture of railway, tramway, and trolleybus rolling stock and lifts and moving stairs.)

(2) *Oerlikon Machine Tool Works Bührle & Co., Machine Tool Division,* Zürich-Oerlikon. (Manufacture of lathes; carbide and other tool grinders; boring, planing, milling and drilling machines; hydro-copying attachments, &c.)

(3) *Oerlikon Machine Tool Works Bührle & Co., Electrode Manufacture Division,* Zürich-Oerlikon. (Manufacture of press coated electrodes for shielded-metal-arc welding; arc welding transformers and converters; electrode presses; welding machines; argon-gas shielded-arc welding, &c.)

(4) *Micafil, Ltd.*, Zürich-Alstetten. (Manufacture of electrical insulation; capacitors and high-voltage apparatus; vacuum pumps; laminated, moulded, and injection-moulded plastics; wire winding machines, &c.)

(5) *Maag Gear-Wheel Co., Ltd.*, Zürich. (Manufacture of gear-cutting and gear-grinding machines, and gear testing equipment.)

(6) *Escher-Wyss Engineering Works, Ltd.*, Zürich. (Manufacture of water- and steam-turbines; pumps; ships' propellers; propeller-milling machines; turbo-compressors, turbo-blowers, and axial fans; variable-pitch airscrews; refrigerating machines; heat pumps; centrifugal separators; pipelines and boilersmith work. Cast-iron and non-ferrous foundry.) (*Note :* Those taking part in this visit are requested to join Group 3 on Tuesday afternoon.)

5.0 p.m. approx. Arrive back at hotels.

B.—VISIT FOR LADIES (AND MEMBERS), WHO HAVE REGISTERED FOR THE MEETING.

2.30 p.m., promptly *Sight-seeing tour of Zürich,* by motor coach. Depart from Kongresshaus.

4.45 p.m., approx. Arrive back at hotels.

EVENING PROGRAMME (MEMBERS, LADIES, AND GUESTS REGISTERED)

6.0 p.m. *Official Reception* by the authorities of the Canton or City of Zürich. (Day dress.)

8.0 p.m. Free in Zürich.

Tuesday, 7 September

9.30 a.m. to 12.30 p.m. and 2 p.m. to 6 p.m. The Secretary's Office will be open at the Eidgenössische Technische Hochschule, Zürich, for the Registration of members and guests and the issue of tickets, badges, literature, &c.

A.—VISITS FOR MEMBERS WHO HAVE REGISTERED FOR THE MEETING (ticket-holders). (The total numbers for each visit are strictly limited.)

Group 1

8.49 a.m. Depart by train from Zürich main station.

9.06 a.m. Arrive at Baden.

9.30 a.m. (7) *Brown-Boveri and Co., Ltd.*, Baden. (Manufacture of steam- and gas-turbines; boilers and accessories; power generators and power-station equipment; power distribution equipment; industrial electrical equipment (motors, switchgear, galvanizing plant, furnaces and kilns, boilers, welding plant); heat pumps; turbo-compressors and blowers; electrical equipment for locomotives, motor coaches, and ships' propelling machinery; high-frequency, communications, and remote control equipment; gearing, &c.)

12 noon Lunch by invitation of the Company.

1.30 p.m. Visit, by motor coach, by invitation of Brown-Boveri and Co., Ltd., to
(9) *Hydraulic Power Station, Wildegg-Brugg*, and
(10) *Gas-Turbine Power Station, Beznau*, of the Nord Ostschweizerische Kraftwerke (N.O.K.).
5.29 p.m. Depart by train from Baden.
5.48 p.m. Arrive at Zürich main station.

Group 2

8.49 a.m. Depart by train from Zürich main station.
9.06 a.m. Arrive at Baden.
9.30 a.m. (8) *A.G. Oederlin and Co., Ltd.*, Baden. (Foundries for light and heavy non-ferrous metals; workshops for the production of water-, gas-, steam-, and acid-fittings; hot-forging (presses 200–1000 tons capacity)).
12 noon Lunch by invitation of the Company.
1.30 p.m. Visit, by motor coach, by invitation of Brown-Boveri and Co., Ltd., to:
(9) *Hydraulic Power Station, Wildegg-Brugg*, and
(10) *Gas-Turbine Power Station, Beznau*, of the Nord Ostschweizerische Kraftwerke (N.O.K.).
5.29 p.m. Depart by train from Baden.
5.48 p.m. Arrive at Zürich main station.

Group 3

8.45 a.m. Depart by motor coach from Swiss National Museum (Landesmuseum).
9.15 a.m. (11) *Oerlikon Engineering Co.*, Zürich-Oerlikon. (Electric locomotives, tramways, and trolley-buses; electrical power-station equipment; steam turbines.) (*Note:* Those who wish to take part in the visit to Escher-Wyss on the preceding day are requested to take part in this (Group 3) visit also, and will be given priority.)
11.20 a.m. Depart, by motor coach, for Einsiedeln.
12.30 p.m. Lunch at Einsiedeln by invitation of Escher-Wyss Engineering Works, Ltd., and the Oerlikon Engineering Co.
2.30 p.m. Depart, by motor coach, for a visit to:
(12) *Hydraulic Power Station, Etzel*, of the Swiss Federal Railways and the Nord Ostschweizerische Kraftwerke (N.O.K.).
6 p.m. approx. Arrive back at hotels.

B.—Visits for Ladies (and Members) who have Registered for the Meeting (ticket-holders).

Group 4

Morning Free in Zürich.
2.15 p.m. Assemble at the Swiss National Museum, for visits, with Guides, to
(a) *Landesmuseum* (*Swiss National Museum*) and
3.45 p.m. (b) *Kunsthaus* (*Art Gallery*), or
(c) *Museum Rietberg* (oriental collections; permanent exhibition of Extra-European art (Edw. von der Heydt collection)), or
(d) *Kunstgewerbemuseum* (*Museum of Applied Arts*).
5 p.m. Return, on own, to hotels.

Evening Programme (Members, Ladies, and Guests Registered)

7.30 p.m. Depart, by motor coaches, from hotels, for Grand Hotel Dolder.
8 p.m. *Official Banquet* at the Grand Hotel Dolder, by invitation of the Société Suisse des Constructeurs de Machines and the Association Suisse pour l'Essai des Matériaux. (Day dress.)
from 11 p.m. Shuttle motor-coach service from Grand Hotel Dolder to the centre of Zürich.

Wednesday, 8 September

Location: Eidgenössische Technische Hochschule, Zürich.

9.0 a.m. to 12.30 p.m. The Secretary's Office will be open for the Registration of members and their guests and the issue of tickets, badges, and literature.
9.30 a.m. *Scientific Session* in Auditorium III. Discussion of the following two papers published in the *Journal*:

(*a*) "The Influence of Extrusion Direction on the Corrosion and Stress-Corrosion of Aluminium-Copper–Magnesium Alloys", by E. A. G. Liddiard and (Miss) W. A. Bell (Serial No. 1534; May, 1954).
(*b*) "Staining of Clad Aluminium Alloy Sheets During Salt-Bath Heat-Treatment", by E. C. Williams and H. J. G. Challis (Serial No. 1541; June, 1954).

12 noon Adjournment.
2.0 p.m. Members and ladies depart from the Swiss National Museum (Landesmuseum) by motor coaches for the following visits:

A.—Visits for Members who have Registered for the Meeting (tickets-holders only), by invitation, to one of the following. (The total numbers for each visit are strictly limited.)

2.45 p.m. (13) *Sulzer Brothers, Ltd.*, Winterthur. (Manufacture of a wide range of products, including diesel engines; boiler plants; heating and ventilating installations; pumps; fans; gas- and steam-turbines; compressors; refrigerating plant; high-pressure equipment; heat pumps; weaving machines; and dry coke cooling plant. The production of the foundries for cast iron and steel (including nodular cast iron), non-ferrous and precision castings is 20,000 tons per annum.)
2.45 p.m. (14) *Swiss Locomotive and Machine Works* (*S.L.M.*), Winterthur. (Manufacture of steam, electric, and diesel locomotives and railcoaches; internal-combustion engines; rotary air and gas compressors; vacuum pumps, and oil-operated reverse and reduction gears, particularly for diesel-driven rail vehicles and ships.)
2.45 p.m. (15) *J. J. Rieter and Co., Ltd.*, Winterthur. (Manufacture of textile machinery.)
2.45 p.m. (16)/(17) *Metallarbeiterschule* (*Metal Workers' School*) and *Werkmeisterschule* (*Foremen's School*), Winterthur.

2.45 p.m. (17)/(16) *Werkmeisterschule (Foremen's School)* and *Metallarbeiterschule (Metal Workers' School)*, Winterthur.

The Metal Workers' School provides careful practical training, combined with theoretical study of mechanics and precision mechanics, to turn out versatile and efficient workers; the full course lasts four years and replaces an industrial apprenticeship. The Foremen's School was founded by the Employers' Association of the Swiss Mechanical Engineering and Metal Industries. Its courses (13 weeks) are primarily intended to give foremen the knowledge and self-assurance needed for their responsible appointments.

B.—Ladies (and Members) Registered for the Meeting (ticket-holders only).

2.45 p.m. *Visit to the Reinhart Art Gallery, Winterthur*, followed by Tea at the "Club zur Geduld", by invitation of the three above-mentioned industrial firms of Winterthur.

C.—All Members and Ladies from (A) and (B) above.

5.15 p.m. Depart, by motor coach, to visit *Kyburg Castle*, near Winterthur.

Light dinner at Kyburg Castle, by invitation of Sulzer Brothers, Ltd.; the Swiss Locomotive and Machine Works (S.L.M.), and J. J. Rieter and Co., Ltd.

8.30 p.m. approx. Arrive, by motor coach, in Zürich.

Thursday, 9 September

All-Day Excursion to Schaffhausen for Members and Ladies Registered for the Meeting (ticket-holders only). (The total numbers for each visit are strictly limited.)

8.41 a.m. Depart by special train from Zürich main station.

9.23 a.m. Train stops for 4 minutes to enable visitors to see the Rhine Falls.

A.—Members' Visits. (The total numbers for each are strictly limited.)

Group 1

9.29 a.m. Arrive at Neuhausen. Visits to one of the following:

(18) *Swiss Industrial Company*, Neuhausen-am-Rheinfall. (Manufacture of railway rolling stock; electric vehicles; packing machines; machine tools; equipment for machining gunbarrels; small arms; hydraulic control units; screw pumps; and pneumatic tools.)

(19) *Research Laboratories of the Société Anonyme pour l'Industrie de l'Aluminium*, Neuhausen-am-Rheinfall. (The laboratories are engaged on research on the production, properties, and processing of aluminium and its alloys; they also give advice to users and instructional courses for light-metal craftsman and technologists. There is a Special Library and department for keeping records of patents.)

Group 2

9.35 a.m. Arrive at Schaffhausen. Visits to one of the following:

(20) *George Fischer, Ltd., Steel Foundry and Grey Iron Division "Ebnat"*, Schaffhausen.

(21) *George Fischer, Ltd., Machine Works "Ebnat"*, Schaffhausen. (Manufacture of machinery, especially copying-lathes and Foundry Equipment Divisions.)

(22) *Alfred J. Amsler and Co.*, Schaffhausen. (Manufacture of materials testing machines and mathematical instruments.)

B.—Ladies (and Members) Registered for the Meeting (ticket-holders only).

Group 3

9.35 a.m. Arrive at Schaffhausen.

Visit to the "Allerheiligen" museum, Schaffhausen.

C.—Members and Ladies of Groups 1, 2, and 3.

12.15 p.m. *Lunch in the Casino*, Schaffhausen, by invitation of the host companies of Neuhausen-am-Rheinfall and Schaffhausen (arrive by motor-coaches provided by the hosts).

2.0 p.m. Members visit (limited to 40), by motor coach, provided by the hosts, to

(23) *Iron Library of George Fischer, Ltd.*, at Paradies.

Tea, by invitation of the hosts

or

Members and ladies:

2.07 p.m. Depart from Schaffhausen, by special train.

2.26 p.m. Arrive at *Stein-am-Rhein*.

Return on the Rhine, by boat, to Schaffhausen.

4.40 p.m. Arrive at Schaffhausen.

Tea, by invitation of the host companies of Neuhausen-am-Rheinfall and Schaffhausen.

5.15 p.m. Depart from Schaffhausen, by special train, for Zürich via Winterthur.

6.16 p.m. Arrive at Zürich main station.

Evening Programme

Location: Eidgenössische Technische Hochshule, Zürich, Auditorium Maximum.

8.30 p.m. *Autumn Lecture, by Professor Dr. A. von Zeerleder, on "Attempts to Improve Aluminium Reduction Since Hérault and Hall"*.

Light refreshments after the Lecture, offered by the Interessengemeinschaft der Schweizerischen Aluminium-hütten-Walz und Presswerke.

Friday, 10 September

Location: Eidgenössische Technische Hochschule, Zürich.

9.0 a.m. (24) Visits (limited numbers) to one of the following:

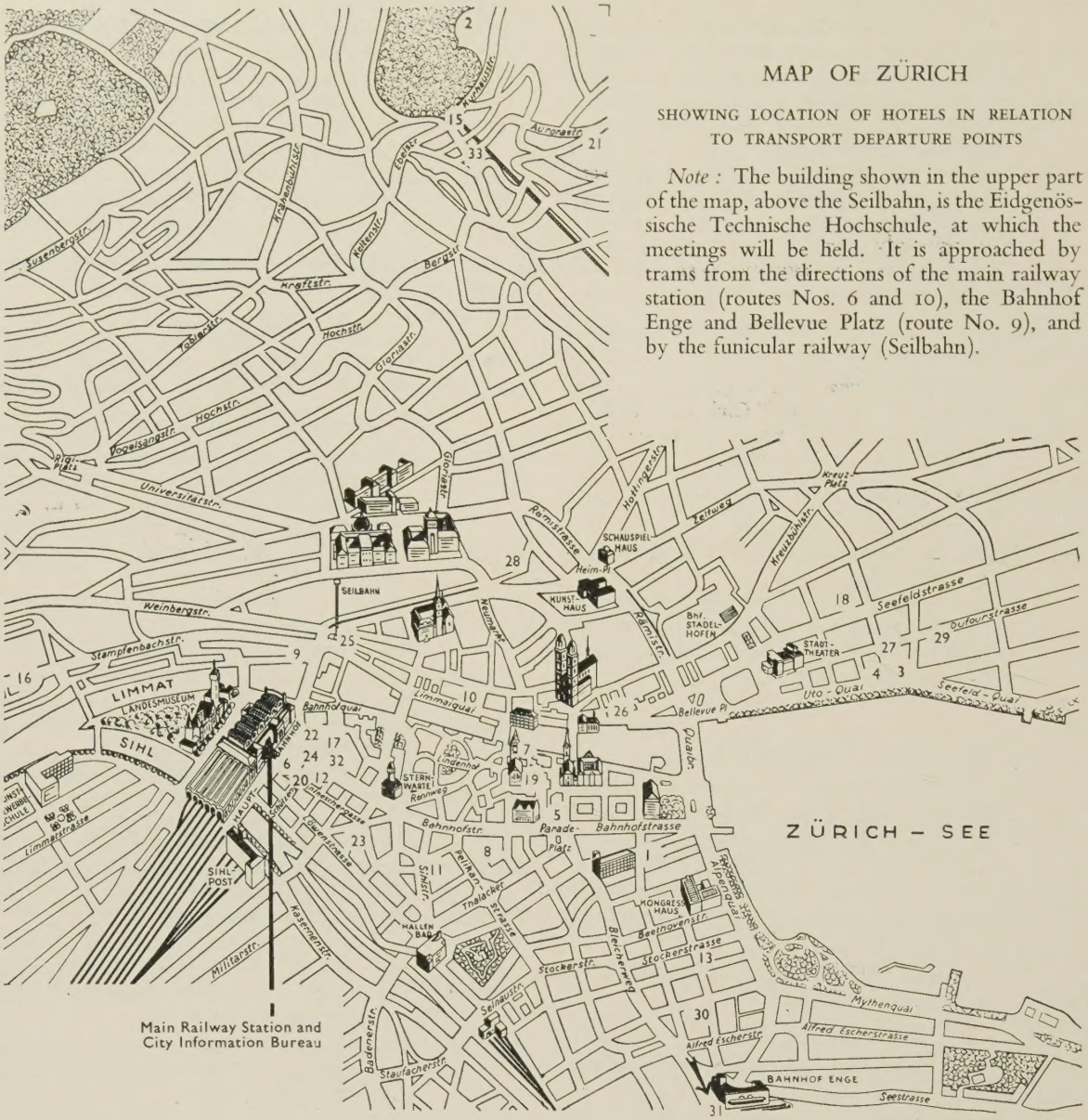
(a) *Eidengenössische Materialprufungs- und Versuchsanstalt* (EMPA) (Federal Testing Laboratories) (Professor Dr. E. Brandenberger) and Technical Institutes of the E.T.H.

(b) *Physical Department*. (Professor Dr. P. Scherrer). Cyclotron and solid states.

MAP OF ZÜRICH

SHOWING LOCATION OF HOTELS IN RELATION TO TRANSPORT DEPARTURE POINTS

Note : The building shown in the upper part of the map, above the Seilbahn, is the Eidgenössische Technische Hochschule, at which the meetings will be held. It is approached by trams from the directions of the main railway station (routes Nos. 6 and 10), the Bahnhof Enge and Bellevue Platz (route No. 9), and by the funicular railway (Seilbahn).


ZÜRICH – SEE
LIMMAT
SIHL
SEILBAHN
Main Railway Station and City Information Bureau
BAHNHOF ENGE
Bahnhofstrasse
Parade-Platz
Seefeldstrasse
Seestrasse
Mythenquai
Alfred Escherstr.
Stockerstrasse
Beethovenstr.
Bleicherweg
Talacker
Rämistrasse
Universitätstr.
Weinbergstr.
Stampfenbachstr.
Limmatquai
Bahnhofquai
Bellevue Pl.
Utoquai
Seefeldquai
Dufourstrasse
Zeltweg
Hottingerstr.
Kreuzplatz
Kreuzbühlstr.
Hochstr.
Hirschengraben
Schanzengraben
Sihlquai
Sihlpost
Limmatstrasse
Militärstr.
Badenerstr.
Stauffacherstr.
Seinaustr.
Kasernenstr.
Fraumünsterstr.
Münsterhof
Rennweg
Augustinergasse
Rämistrasse
Heim-Pl.
Schauspielhaus
Kunsthaus
Bhf. Stadelhofen
Stadttheater
Kongresshaus
Hallenbad
Sternwarte
Landesmuseum
Eidgenössische Technische Hochschule
Rigiplatz
Vogelsangstr.
Susenbergstr.
Freiestr.
Kreuzstr.
Rötelstr.
Hirschengraben
Zähringerstr.
Rämistrasse
Neumarkt
Münsterhof
Fraumünsterstr.
Augustinergasse
Rennweg
Talacherstr.
Feldeggstr.
Gloriastr.
Bergstr.
Hochstr.
Tiefenhof
Paradeplatz
Bahnhofstrasse
Limmatstrasse
Sihlquai
Sihlpost
Militärstr.
Kasernenstr.
Badenerstr.
Stauffacherstr.
Seinaustr.
Alfred Escherstr.
Mythenquai
Seestrasse
Bleicherweg
Beethovenstr.
Stockerstrasse
Talacherstr.
Hallenbad
Kongresshaus
Sihlquai
Bahnhofquai
Limmatquai
Bellevue Pl.
Utoquai
Seefeldquai
Dufourstrasse
Seefeldstrasse
Zeltweg
Kreuzplatz
Kreuzbühlstr.
Hottingerstr.
Rämistrasse
Schauspielhaus
Heim-Pl.
Kunsthaus
Bhf. Stadelhofen
Stadttheater
Weinbergstr.
Stampfenbachstr.
Universitätstr.
Rigiplatz
Vogelsangstr.
Hochstr.
Susenbergstr.
Freiestr.
Kreuzstr.
Rötelstr.
Bergstr.
Gloriastr.
Hirschengraben
Zähringerstr.
Augustinergasse
Fraumünsterstr.
Münsterhof
Rennweg
Sternwarte
Landesmuseum
Eidgenössische Technische Hochschule
Limmatstrasse

(c) *Metallurgical Laboratories* (Professor Dr. R. Durrer).
(d) *Cryogenic Laboratory* (Professor Dr. P. Grassmann). Helium liquefier, &c.
(e) *Institute for Hydraulic Machines and Hydraulic Power Installations* (Professor H. Gerber). Machines and hydraulic tests.
(f) *Laboratory for Photoelasticity* (Professor Dr. H. Favre).
(g) *Mechanical Engineering Laboratory and District Heating Plant* (Professor Dr. E. Honegger).

10.30 a.m. *Discussion on the Theme: The Constitution of Titanium Alloys.* A discussion based on the following papers (to be introduced by a Rapporteur) published in the *Journal*:

"The Structure of Titanium–Tin Alloys in the Range 0–25 At.-% Tin", by H. W. Worner (Serial No. 1473; July, 1953).
"The Reinvestigation of a Nickel–Titanium Alloy and Observations on $\beta/(\alpha + \beta)$ Boundaries in Titanium Systems", by A. D. McQuillan (Serial No. 1494; Sept., 1953).
"The Free-Energy Diagram of the System Titanium–Oxygen", by O. Kubaschewski and W. A. Dench (Serial No. 1500; Oct., 1953).
"The Structure of Titanium–Silver Alloys in the Range 0–30 At.-% Silver", by H. W. Worner (Serial No. 1515; Jan., 1954).
"A Redetermination and Interpretation of the Titanium-Rich Region of the Titanium–Chromium System", by (Mrs.) M. K. McQuillan (Serial No. 1535; May, 1954).
"Methods for Determining the Liquidus Points of Titanium-Rich Alloys", by W. Hume-Rothery and D. M. Poole (Serial No. 1545; June, 1954).
"Note on the Constitution of the Titanium–Gold System in the Region 0–6 At.-% Gold", by (Mrs.) M. K. McQuillan (Serial No. 1548; July, 1954).
"The Constitution of the Titanium-Rich Alloys of Titanium, Iron, and Oxygen", by N. P. Allen, T. H. Schofield, and (Mrs.) B. Mellish (Serial No. 1551; July, 1954).

11.55 a.m. Adjournment.
12 noon Concluding Business and Votes of Thanks.
Aft. Free in Zürich.
5.30 p.m. *Cocktail Party, Given by Members and Ladies of the Institute of Metals, for their Hosts*, on the M/S *Linth*; steamer trip on the Lake of Zürich to Wädenswil.
7 p.m. Return to Zürich.
Evg. Free.

Saturday, 11 September

8.50 a.m. Depart, by special train, from Zürich main station. (*Note:* Thos. Cook and Son, Ltd., will arrange for all except hand-luggage to be sent direct from Zürich to Montreux, as trains have to be changed twice during the journey by members and ladies en route over the Bernese Oberland. Those who have made their own travel and hotel arrangements but wish to travel by this special train must obtain tickets from, and arrange for the handling of their baggage by, the Zürich office of Thos. Cook & Son, Ltd.)
9.46 a.m. Arrive in *Lucerne*; free in the town until
11.55 a.m. Departure, by special train, via Brünig and Meiringen to Interlaken (packed lunch will be taken on the train).
2.05 p.m. Arrive at Interlaken and change train.
2.18 p.m. Depart, by special train, for Zweisimmen.
3.31 p.m. Arrive at *Zweisimmen* (944 m.).
Tea.
Depart by two special trains for Montreux via Bernese Oberland.
First Train:
4.29 p.m. Depart from Zweisimmen.
6.11 p.m. Arrive at *Montreux*.
Second Train:
4.43 p.m. Depart from Zweisimmen.
6.46 p.m. Arrive at *Montreux*.

Sunday, 12 September

All day Free in Montreux. Thos. Cook and Son, Ltd., will provide information regarding possible excursions for those who wish to take part in them.

Monday, 13 September

A.—MEMBERS WHO HAVE REGISTERED FOR THE MEETING (ticket-holders only). (The numbers who can take part are strictly limited.)

Group 1

8.39 a.m. Depart from Montreux by train for Chippis.
10.01 a.m. Arrive at Sierre; transfer to motor coaches provided by the hosts, and visit:
(25) *Société Anonyme pour l'Industrie de l'Aluminium, Chippis Works.* (Aluminium electrolytic reduction plant; electrode plant; melting and casting section; rolling and extrusion mills.)
1.0 p.m. Lunch, by invitation of the Company.
4.05 p.m. Depart from Sierre by train.
5.27 p.m. Arrive at Montreux.

Group 2

8.30 a.m. Depart from Montreux by motor coach.
10.10 a.m. Arrive at Cossonay, and visit
(26) *Société Anonyme des Câbleries et Tréfileries de Cossonay.* (The most important cable works in Switzerland. There are 9 manufacturing departments: hot-rolling mill; drawing; rope making; cable making; insulating wire; cold-rolling mill; insulating tubes; Pupin coils; and accessories for cables.)
12.30 p.m. Lunch, by invitation of the Company.
3.0 p.m. Depart, by motor coach, via the Corniche road.
5.0 p.m. Arrive at Montreux.

Group 3

8.43 a.m. Depart from Montreux by train.
10.13 a.m. Arrive at Geneva and visit one of the following three works:
(27) *Ateliers des Charmilles S.A.*, Geneva. (Manufacture of Kaplan, Pelton, and Francis types of water turbines and governors, valves, and gates for turbines; gears; equipment for rolling stock, &c.)
(28) *Société Genevoise d'Instruments de Physique (S.I.P.)*, Geneva. (Manufacture of machine tools and measuring instruments.)
(29) *Tavaro S.A.*, Geneva. (Manufacture of sewing machines.)
12.30 p.m. Lunch, by invitation of the three host companies.
3.02 p.m. Depart by train from Geneva.
4.29 p.m. Arrive at Montreux.

B.—Ladies (and Members) who have Registered for the Meeting (ticket-holders only).

Group 4

9.0 a.m. An all-day tour, organized by Thos. Cook and Son, Ltd., to the mountains of Gruyère and the Pillon Pass; lunch at Gruyère, and return to Montreux.

10.18 p.m. Party of British members and ladies leaves Montreux by train for London, with couriers.

Tuesday, 14 September

Visits, en Route to Basle, for Members and Ladies.

Important Note. These visits being made *en route* from Montreux to Basle, on the homeward journey, the rail fare will be covered by Thos. Cook and Son, Ltd., inclusive charges. Members *not* booking through Cooks will have to pay the rail fare, which is *not* covered by the Registration Fee.

Group 1

8.28 a.m. Depart by motor-rail coach from Montreux.
10.54 a.m. Arrive at Reconvilier and visit
(30) *Fonderie Boillat S.A.*, Reconvilier. (Manufacture of semi-finished products (450–700 tons per month): common leaded and lead-free brasses; high-tensile brasses; nickel silver; bronzes. Bar, rod, sections, wire, sheet, strip and blanks. Specializes in high-precision brass for the watch industry; free-cutting brasses; and complicated, extruded and drawn sections.)
Lunch, by invitation of the Fonderie Boillat S.A. and Metallwerke A.G., Dornach.
2.05 p.m. Depart from Reconvilier by motor-rail coach.
3.06 p.m. Arrive at Dornach and visit
(31) *Metallwerke A.G., Dornach.* (Produce approx. 900–1200 tons per month of semi-finished non-ferrous products: copper, brasses, bronzes, nickel silver, pure copper, nickel, in the forms of bars, rod, sections, wire, sheet, strip, blanks and circles, tubes, etc. Manufacture of cartridge cases, coin blanks, high-precision strip, printing metals, condenser plates, etc. Mild steel is produced mainly as a base metal for clad steel (bullet envelopes).)
Tea, by invitation of the Company.
6.29 p.m. Depart from Dornach by motor-rail coach.
6.38 p.m. Arrive at Basle, en route for London.
Dinner at Baselstab Restaurant, Basle.

Group 2

7.51 a.m. Depart by motor-rail coach from Montreux.
10.03 a.m. Arrive at Solothurn.
Ladies leave for sight-seeing by invitation of the host Company.
10.10 a.m. Members depart from Solothurn for Gerlafingen, and visit
(32) *Louis de Roll Iron Works, Ltd.*, Gerlafingen. (Production of pig iron and oxygen-blown steel; rolling mills, forging plant and machine shops. Main products are bolts and nuts, installation material for electrical conductors, welded tubes and containers, &c.)
12.12 p.m. Depart from Gerlafingen for Solothurn by rail.
Lunch (members and ladies) by invitation of the Company.
2.35 p.m. Depart from Solothurn by motor-rail coach.
3.26 p.m. Arrive at Choindez and visit
(33) *Electric Low-Shaft Furnace Plant of Louis de Roll Iron Works, Ltd.*
Tea, by invitation of the Company.
5.54 p.m. Depart from Choindez by motor-rail coach.
6.31 p.m. Arrive at Basle, en route for London.
Dinner at Baselstab Restaurant. Basle.

GENERAL INFORMATION

Registration Fee. The following Registration Fees will be charged to cover expenses indicated below. These fees (Swiss francs only) can either be paid through Thos. Cook and Son, Ltd., or when registering in Zürich.

Zürich Only	*Swiss Francs*
Members and Male Guests . .	75
Ladies	65
Zürich and Montreux	
Members and Male Guests . .	95
Ladies	90

These fees include:

(*a*) Normal Registration fee to cover general administration expenses, meeting badge, provision of tickets, literature, &c.
(*b*) Motor coaches E.T.H. to Kongresshaus.
(*c*) Lunch on 6 September, including gratuities (but not including drinks).
(*d*) Ladies visits, including guides.
(*e*) Rail fares or motor coaches for all visits, excluding those on Tuesday, 14 September (homeward journey).
(*f*) Transport to and from Dolder Grand Hotel for banquet.
(*g*) Cocktail party given for Institute's hosts (including hire of steamship).
(*h*) Lunch for ladies (and members, if accompanying), on all-day tour of mountains on Monday, 13 September.

Meals.

If they accept the invitations to social functions or works, &c., visits, or take part in tours covered by the Registration Fee, members and guests will *not* have to make arrangements for main meals as detailed below:

	Members	*Ladies*
Mon., 6 Sept.	Lunch	Lunch
Tues., 7 Sept.	Lunch	
	Dinner	Dinner
Wed., 8 Sept.	Dinner	Dinner
Thurs., 9 Sept.	Lunch	Lunch
Sat., 11 Sept.	(Lunch on train)	(Lunch on train)
Mon., 13 Sept.	Lunch	Lunch
Tues., 14 Sept.	Lunch	Lunch

Dress. Evening dress will NOT be required at any social function.

Travel and Accommodation. Members wishing to book through Thos. Cook and Son, Ltd., should do so at the earliest possible moment to the Post-Order Department, Thos. Cook and Son, Ltd., Berkeley Street, London, W.1, quoting reference POD/S/22222.

Hotels in Zürich. A map of Zürich, showing the location of the main hotels in relation to the starting points for transport for visits is printed on page 126, for members' information.

Ladies' Programme. In view of the attractions of the city, it has been thought wise to leave the ladies as much freedom as possible while they are in Zürich. As regards the visits arranged, it is possible that an alternative all-day or half-day visit may be arranged for Tuesday, 7 September; if so, particulars will be given in the final programme which will be despatched in July to all members resident in Europe.

Papers and Discussions. It will be assumed that all present at the technical sessions will have read the papers; in consequence, they will not be presented by the authors.

Members intending to take part in the discussions are requested to state their intention of doing so as early as possible. Apart from the opening speakers, contributors to the discussions will be limited to a maximum of 10 minutes.

Special Trains to Montreux. It is particularly emphasized that, as trains have to be changed twice during the journey, heavy baggage can *not* be taken on the special trains from Zürich to Montreux. It will be cared for by Thos. Cook and Son, Ltd., and will be delivered to members' hotels.

Election of Council for 1955–56

In accordance with the Articles of Association, the following are due to retire from the Council at the 1955 Annual General Meeting: *President:* S. F. DOREY, C.B.E., D.Sc., F.R.S. *Past-President:* C. J. SMITHELLS, M.C., D.Sc. *Vice-President:* G. L. BAILEY, C.B.E., M.Sc. *Honorary Treasurer:* J. C. COLQUHOUN, M.B.E. *Ordinary Members of Council:* K. W. CLARKE and CHRISTOPHER SMITH.

Under Article 19, Dr. S. F. DOREY, C.B.E., D.Sc., F.R.S., will fill the vacancy on the Council as Past-President.

Mr. J. C. COLQUHOUN, M.B.E., having been appointed by the Council to fill a vacancy occurring during the year 1954–55, in accordance with Article 28, is eligible for re-election as Honorary Treasurer.

In accordance with Article 22, the Council nominates the following members to fill the vacancies:

As President:

MAURICE COOK, D.Sc., Ph.D., F.I.M., Joint Managing Director, Imperial Chemical Industries, Ltd., Metals Division, Birmingham.

As Vice-Presidents

Mr. E. H. JONES, A.R.I.C., M.I.M.M., F.I.M., Joint Managing Director, Capper Pass and Son, Ltd., Bristol.

Mr. W. J. THOMAS, M.I.Mech.E., M.I.E.E., Joint Managing Director, The British Aluminium Company, Ltd., London.

As Honorary Treasurer:

Mr. J. C. COLQUHOUN, M.B.E., Chairman and Managing Director, The Manganese Bronze and Brass Company, Ltd., London.

As Ordinary Members of Council:

Mr. L. E. BENSON, M.Sc., F.I.M., Metallurgist, Metropolitan-Vickers Electrical Company, Ltd., Manchester.

Mr. C. F. J. FRANCIS-CARTER, O.B.E., F.R.I.C., M.I.Chem.E., F.I.M., General Manager, Aluminium Wire and Cable Company, Ltd., Swansea.

Mr. D. P. C. NEAVE, M.A., M.I.Mech.E., Managing Director, Imperial Smelting Corporation, Ltd., London.

Professor H. O'NEILL, M.Met., D.Sc., F.I.M., Professor of Metallurgy, University College of Swansea.

Members are reminded that, in accordance with Article 22, any ten members may also at, or before, the business part of the Autumn General Meeting (6–10 September 1954), nominate in writing, with the written consent to act if elected of the person nominated, any duly qualified person other than one of those nominated by the Council to fill any vacancy on the Council, but each such nominator is debarred from nominating any other person for the same election. If two or more persons are nominated for any honorary office they (or such of them as are not Ordinary Members of Council who are not retiring at the next Annual General Meeting) will be deemed to have been nominated also for any vacancies among the Ordinary Members of Council. No person is eligible to fill any vacancy at such Annual General Meeting unless he has consented in writing to be nominated and has been nominated or deemed to be nominated for the same in compliance with this Article.

Senior Vice-President, 1955–56

The Council has elected Major C. J. P. BALL, D.S.O., M.C., F.R.Ae.S., to serve as Senior Vice-President for 1955–56, and he will be their nominee for the Presidency in 1956–57.

The W. H. A. Robertson Medal and Premium

The W. H. A. Robertson Bronze Medal and a Premium of Fifty Guineas are awarded annually by the Council to the author or authors of the paper adjudged to be of the highest merit contributed to the *Journal of the Institute of Metals* on engineering aspects of non-ferrous metallurgy. No award is made if, in the Council's opinion, no paper published during the year is of sufficient merit to justify the award.

The medal and award are placed at the disposal of the Council by the Directors of W. H. A. Robertson and Co., Ltd., of Bedford, who, having in mind the few papers contributed to the *Journal* dealing with the engineering side of non-ferrous metal production, and believing that such papers would be to

the advantage of the Institute and the industry, offered the sum of £100 a year, for a period of not less than seven years, to stimulate the writing of papers of this kind.

The objects which the donors had in mind are warmly approved by the Council, which regrets that no papers were published in the *Journal* in 1953 which strictly came within the terms of the awards. The Council particularly hopes, however, that the offer of the W. H. A. Robertson Medal and Premium will stimulate the submission of papers on engineering aspects of non-ferrous metallurgy for publication by the

THE W. H. A. ROBERTSON MEDAL (Full-size).

Institute and discussion at its General Meetings. The Metallurgical Engineering Committee also will be grateful to members of the Institute if they will encourage suitable members of their staffs to submit papers of a high standard for the consideration of the Publication Committee.

The award is open to persons of any nationality and of either sex, and to non-members as well as to members of the Institute. MSS. of papers should be addressed to the Secretary of the Institute in the normal way. All published papers are considered for the award annually by the Medal Committee, with the advice of the Metallurgical Engineering Committee.

The obverse of the medal, which was designed by Mr. Percy Metcalfe, C.V.O. is reproduced above. The figure represents Hephaistos, the god of fire and smiths.

PERSONAL NOTES

Mr. J. H. Auld has been transferred from the Crystal Physics Section of the Defence Research Laboratories to the Crystal Physics Section of the Aeronautical Research Laboratories, Melbourne.

Mr. G. R. Bish, of Enfield Cables, Ltd., has been awarded the Andrew Carnegie Silver Medal of the Iron and Steel Institute for his report, written in conjunction with Professor H. O'Neill (who is not eligible for the award), on "The Deformation of Austenite in Relation to the Hardness Characteristics of Steel".

Mr. George Boex retired from his post as Joint Managing Director of The British Aluminium Co., Ltd., on 4 July. He will, however, continue to be a Director of the Company, and has agreed to undertake special work as consultant as requested by the Company.

Dr. J. W. Cuthbertson has been elected to the newly endowed Cripps Chair of Metallurgy in the University of Nottingham. He takes up his duties on 1 September. Dr. Cuthbertson has been Assistant Director of Research to the Tin Research Institute since 1944; before that he was for a number of years a Lecturer in the Department of Metallurgy at Manchester University. He is President of the Institute of Metal Finishing.

Mr. H. G. Fales has been appointed Assistant to the Chairman of the Board of the International Nickel Company of Canada, Ltd. He will continue to be an Assistant Vice-President of the Company.

Mr. E. Gregory has been awarded the Ph.D. degree of Cambridge University. He is now with the Manganese Bronze and Brass Co., Ltd., Ipswich.

Mr. M. M. Hallett has been appointed Director of Research to three Sheepbridge group companies: Sheepbridge Stokes, Ltd., Chesterfield, Sheepbridge Equipment, Ltd., Chesterfield, and Sheepbridge Steel Castings, Ltd., Sutton-in-Ashfield, Notts. Mr. Hallett will be responsible for the Research and Development Laboratories at Sheepbridge Engineering, Ltd., the parent company, and also for the technical control of the group foundries.

Professor Emilio Jimeno, of the University of Madrid, has recently been awarded the degree of Dr.-Ing. (*honoris causa*) by the Technische Hochschule, Hannover.

Mr. Essington Lewis, Chairman of Broken Hill Pty. Co., Ltd., has been awarded the Gold Medal of the Institution of Mining and Metallurgy in recognition of his long and distinguished services to the mining and metallurgical industries of Australia.

Dr. J. W. Martin has been elected into Fellowship at St. John's College, Cambridge.

Dr. Paul D. Merica has retired from the position of President of the International Nickel Company of Canada, Ltd. He continues as a Director of the Company and Member of its Executive Committee, and will also act as a consultant on special projects.

Professor E. A. Owen retires in September from the Chair of Physics at the University College of North Wales, Bangor, which he has held for the last 28 years. Before going to Bangor he was head of the Radiology Section of the Physics Department of the National Physical Laboratory, and undertook there some of the earliest X-ray work on the structure of metals and alloys.

Mr. R. D. Parker has been appointed General Manager of Canadian Operations of the International Nickel Company of Canada, Ltd. He will continue to be an Assistant Vice-President of the Company.

Mr. R. T. Priestman, Managing Director of T. J. Priestman, Ltd., has been elected President of the Aluminium Development Association for the year 1954–55. He represents ALAR, Ltd., on the A.D.A. Council.

Dr. R. J. Raudebaugh has recently accepted an appointment in the Research Laboratory of the International Nickel Co., Bayonne, N.J. Until the beginning of this year he had been in charge of the metallurgy course at the Georgia Institute of Technology, Atlanta, Ga.

Dr. S. F. Reiter has left the Research Laboratories of The General Electric Co., Schnectady, N.Y., and has been appointed Technical Director of Rome Fastener Corp., New Haven, Conn.

Dr. Paul Schwarzkopf, President of the American Electro Metal Corp., Yonkers, N.Y., has been elected Vice-President and a member of the Board of Directors of the recently formed Borolite Corp., Niagara Falls, N.Y.

Mr. F. M. Thomas has taken up an appointment with Imperial Chemical Industries, Ltd., Witton, Birmingham.

LETTER TO THE EDITOR

Descaling and Brightening of Titanium and its Alloys with Pyrophosphoric Acid

Pyrophosphoric acid at 270° ± 10° C. will remove the common, dark-grey oxide layers from hot-worked or heat-treated titanium and titanium-rich alloys in ¼–1 min., the actual time required depending on the thickness of the oxide. The metal or alloy is left with a bright surface which is much smoother than that obtained by the use of the well-known mixture of concentrated nitric acid (80% by volume) and concentrated hydrofluoric acid (20% by volume).

At temperatures below 260° C., the action of the pyrophosphoric acid is much slower, and dull, or matt, finishes are produced on the exposed metal. If temperatures above 280° C. are used, pitting of the metal is likely to occur.

After treatment in the hot acid, the specimen should be plunged into cold orthophosphoric acid (sp. gr. 1·74) and then into cold water; if the specimen is transferred directly from the hot acid into water, a very vigorous reaction between the acid and water occurs, with the risk of dangerous spitting.

During descaling treatments, a coarse-grained, white precipitate appears in the acid. This precipitate tends to form a troublesome, sintered cake at the bottom of the flask or beaker. From time to time the white material should be allowed to settle; the clear acid can then be decanted into another clean, dry beaker.

The smoothing and brightening effects of pyrophosphoric acid used as outlined above are so marked that a freshly descaled surface is often in a satisfactory condition for etching and preliminary micro-examination. It is also worthy of note that specimens which have been carefully ground and given a rough polish on waterproof, 600-grade carborundum paper, can be chemically polished by treatment for ¼–½ min.

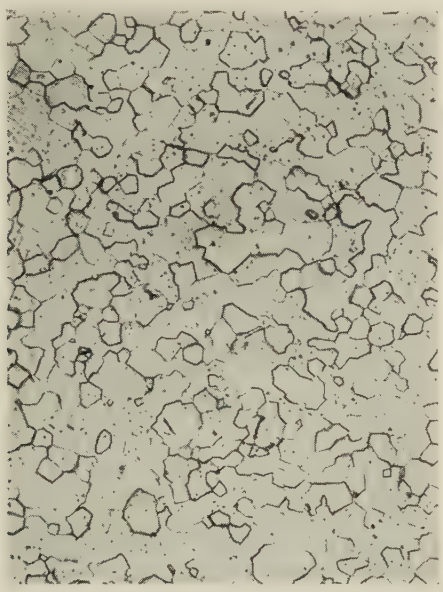


Fig. 1.—Annealed Fine-Grained Titanium. × 450.

Fig. 2.—As-Cast Titanium. × 120.

Figs. 1–2.—Commercial-Purity Titanium, Rough-Polished on 600-Grade Carborundum Paper, then Chemically Polished in Pyrophosphoric Acid, and Finally Etched in 2 wt.-% HNO_3 + 1 wt.-% HF in Water.

Mr. W. J. Thomas has been appointed Joint Managing Director of The British Aluminium Co., Ltd., in place of Mr. G. Boex, who has retired.

Mr. R. G. Ward has received the first award of the J. H. Andrew Research Fellowship in Metallurgy at Sheffield University. This Fellowship has been established through the generosity of the English Steel Corporation, Ltd., Thomas Firth and John Brown, Ltd., and Firth-Vickers, Ltd. Since 1951, Mr. Ward has been carrying out research in the Department of Metallurgy at Cambridge University.

Deaths

The Editor regrets to announce the deaths of:

Mr. Copplestone Arthur James Heckford, formerly Managing Director of Arthur E. Heckford, Ltd., Birmingham, on 18 April at the age of 68. He had been a member of the Institute since 1926.

Mr. Edward Fulton Law, A.R.S.M., Senior Partner of Riley, Harbord and Law, London, on 22 May. Mr. Law was an Original Member of the Institute.

in stirred pyrophosphoric acid at temperatures in the range 260°–280° C. The stirring should be as vigorous as possible consistent with safety. Inadequate stirring favours the formation of pits. Increasing either the temperature or the period of treatment beyond the ranges stated also tends to cause pitting. At temperatures below 260° C., matt finishes rather than mirror-like surfaces are produced.

Figs. 1 and 2 illustrate the results which can be achieved by utilizing the pyrophosphoric acid chemical polish in the preparation of both fine-grained and coarse-grained titanium for micro-examination.

H. W. Worner

Physical Metallurgy Section, C.S.I.R.O.,
Baillieu Laboratory,
University of Melbourne.

JOINT ACTIVITIES

Symposium on Powder Metallurgy, 1954

The Symposium on Powder Metallurgy organized by the Iron and Steel Institute in association with the Institute of Metals, preliminary details of which were given in the April 1954 issue of the *Bulletin*, will be held on Wednesday and Thursday, 1 and 2 December next.

As previously announced, a small exhibition of powder-metallurgy components will be arranged; the purpose will be to show, not so much ordinary parts in normal production, but specimens with special characteristics or examples of the application of powder metallurgy to problems difficult of solution by other methods. Any company in the United Kingdom wishing to display components in this exhibition is invited to submit a list of proposed specimens, with brief details of their particular points of interest, to the Secretary, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1, to enable the Organizing Committee to select items that could be built up into an exhibition illustrating the present state of development of the production of powder-metallurgy components in the United Kingdom. The Committee reserves the right to accept or reject exhibits at their discretion.

The Iron and Steel Institute cannot accept responsibility for the safety or return of exhibits, but will endeavour to send them back after the meeting, if desired, at owners' expense.

Joint Metallurgical Societies' Meeting in Europe, 1955

The American Institute of Mining and Metallurgical Engineers and the American Society for Metals have accepted invitations from certain metallurgical societies in Great Britain, France, Germany, and Sweden to send representatives to a Joint Metallurgical Societies' Meeting in Europe in June 1955. The approximate dates of the main meeting are 1–7 June in Great Britain, 9–12 June in Düsseldorf, and 14–19 June in Paris. An opportunity will be provided for visiting Liége (Belgium) *en route* from Düsseldorf to Paris on 13 June. Tours will be arranged to other European countries after the conclusion of the main meeting.

The arrangements in Great Britain are being made jointly by The Iron and Steel Institute and The Institute of Metals. The following Continental societies are associated with them in issuing the invitation to the American societies: Société Française de Métallurgie (France), Verein deutscher Eisenhüttenleute and Deutsche Gesellschaft für Metallkunde (Germany), and Jernkontoret (Sweden).

The objects of the meeting are to establish personal contacts between experts in the U.S.A. and in Europe, to provide opportunities for scientific and technical discussion, to enable visitors from the U.S.A. to see something of the metallurgical industries of Europe and to visit places of historical or other interest, and to foster better understanding and co-operation among all concerned.

A detailed list of subjects for discussion will be announced later. They will include various aspects of iron- and steel-making, rolling and forging (but not casting), refining and fabrication of non-ferrous metals, heat-treatment, metallurgical education, and research.

Much of the technical and scientific work of the meeting will be conducted by means of discussion groups, but certain plenary sessions and formal meetings for the presentation and discussion of papers will also be held. The meeting will begin with a Plenary Session in London on Wednesday, 1 June 1955. During the following days, in addition to technical meetings, visits will be paid to laboratories and works and places of general and historical interest in the neighbourhood of London; opportunities for informal discussion will be provided at social functions in the evenings. Visitors from the U.S.A. will be given an opportunity to take part in alternative tours of industrial districts before leaving for the Continent on 8 June. Special arrangements will be made for ladies.

By agreement with the American Societies, the total number of visitors from the U.S.A. will be restricted to 350. Representation of European societies will be arranged by personal invitation. The opportunities that will be provided for members of British Institutes to meet these visitors from the U.S.A. and the Continent will be announced later.

All communications should be addressed to The Honorary General Secretary of the European Committee (K. Headlam-Morley), c/o The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1.

Terms of Capper Pass Awards

The Capper Pass Awards, which are made annually from a sum of £200 placed each year at the disposal of the Councils of the Institution of Mining and Metallurgy and of the Institute of Metals, by the Directors of Capper Pass and Son, Ltd., Bristol, are intended to encourage the publication of papers in the *Transactions of the Institution of Mining and Metallurgy* and in the *Journal of the Institute of Metals* on processes and plant used in extraction metallurgy and on the subject of assaying and of papers on processes and plant used in all branches of the non-ferrous metal industry.

Provided that the Adjudicating Committee is satisfied that the quality and numbers of papers submitted, of the types for which the awards are made, reach a suitable standard:

(*a*) £100 per annum is available for one or more awards to authors of papers on some aspect of non-ferrous extraction metallurgy, including assaying;

(*b*) £100 per annum is available for one or more awards to the authors of papers relating to some processes or plant used in the extraction or fabrication of non-ferrous metals.

The Adjudicating Committee meets annually to consider, on behalf of the two societies, papers published during the past calendar year in the two journals referred to above. It may, at its discretion, make no award or awards of less than the money available, if, in its opinion, the quality or number

of papers submitted in any year fails to reach a suitable standard. Any sums not awarded will be carried forward to future years.

The Councils of the Institution of Mining and Metallurgy and of the Institute of Metals hope that the generous offer made by Messrs. Capper Pass and Son, Ltd., will stimulate the writing of many papers of the types for which the awards are to be made. Papers on extraction metallurgy should preferably be submitted to the Institution of Mining and Metallurgy, while those on processes and plant used in the fabrication of non-ferrous metals should preferably be offered to the Institute of Metals. Both societies are prepared to accept papers from non-members.

Authors should note that applications should not be addressed to the Adjudicating Committee requesting that their papers should be considered for the Award of a Premium. All papers published by both societies will be examined by the Committee annually, and notices of the Awards will be published in the journals of the two societies and in the Press.

NEWS OF KINDRED SOCIETIES

Instituto del Hierro y del Acero

The third General Assembly of the Instituto, previously announced to take place at the end of 1954, has now been postponed until June 1955.

OTHER NEWS

National Physical Laboratory

Extension to the Metallurgy Division

The new Extension, which was opened by Professor Sir Lawrence Bragg, O.B.E., M.A., D.Sc., F.R.S., on 6 April last, has been made necessary by the continuous development of techniques for the study of the fine structure of metals, and the growth of interest in the properties of materials at very high temperatures. It consists of a two-storey building, and accommodates three sections of the Division—the ceramics section, the X-ray section, and a new radioactive-tracer section. Each portion of the building has been designed and equipped to meet the requirements of the particular type of work that will be undertaken in it. Most interest probably lies in the tracer section, whose purpose is to provide for this country a place where these techniques can be applied under suitable conditions to metallic samples, and an assessment made of their value in metallurgical research. The plan underlying the design and equipment of the section has been to provide facilities for carrying out on metals of all but the highest activity, most of the operations normally applied to metals in a research laboratory. The scale of operations envisages handling active metal in quantities up to about 6 lb. It is proposed to offer the facilities of the section to workers in other metallurgical laboratories not so equipped, and also to undertake work on problems submitted by outside organizations. The terms on which these facilities will be available are not yet finalized, but will be announced after sufficient experience has been gained.

The formal opening of the main door of the new building was performed by Sir Lawrence using a presentation key, made in the Division, of titanium ornamented on the shaft with seven other metals. Each metal recalls some past or present major research project of the Division and, in addition, was selected to provide a pleasing overall colour contrast. The wards, stem, and head of the key are made of titanium, arc-melted, forged, rolled, and shaped in the Division. The ornamentation along the stem consists of three thin cylindrical sleeves with four small annular separating rings. The head, into the base of which is screwed the stem, was made separately, and has an insert of gold, on one side of which is engraved the letters N. P. L. and on the other the date of the opening ceremony.

Symposium on the Mechanism of Phase Transitions in Crystals

In connection with the Third International Congress on Crystallography, which is to be held in Paris from 21 to 30 July 1954, a Symposium has been arranged on " The Mechanism of Phase Transitions in Crystals ". On the morning of Tuesday, 27 July, a general introduction will be given by Professor A. Guinier, and Professor B. Warren will deal with X-ray studies of order–disorder changes in alloys. Thursday, 29 July, will be devoted to papers on the mechanism of martensite-type transformations, and on Friday, 30 July, there will be a series of papers on transformations in alloys, ferroelectric and magnetic transformations, and transformations in minerals and inorganic and organic crystals.

Details may be obtained from Dr. A. J. Rose, 1, Rue Victor Cousin, Paris (Ve).

A.S.T.M. Reference Radiographs for Inspection of Aluminium and Magnesium Castings

Reference radiographs prepared by A.S.T.M. Committee E-7 on Non-Destructive Testing have been approved for publication by the Society under the A.S.T.M. Designation E98–53T, and are now available. They illustrate various types and degrees of discontinuities occurring in aluminium and magnesium castings. They also include a concise numerical system for designating the discontinuities based on the Tentative Industrial Radiographic Terminology for Use in Radiographic Inspection of Castings and Weldments (A.S.T.M. Designation: E52).

The reference radiographs have been reproduced from the Bureau of Aeronautics Reference Radiographs dated August 1, 1951, through the courtesy of the U.S. Navy Department, Bureau of Aeronautics. They were selected from a large number of radiographs of aircraft castings accumulated over a period of years, and are considered to be highly representative of the discontinuities frequently found in aluminium and magnesium castings.

The set consists of 62 negatives covering aluminium-alloy castings and 45 negatives covering magnesium-alloy castings. The reference radiographs are contained in a serviceable ring binder of heavy canvas-covered cardboard. Complete sets, price $110, may be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., U.S.A.

University College, Swansea

A silver gilt " Sidney Gilchrist Thomas Medal " has been inaugurated at the University College of Swansea, thanks to the generosity of Mr. A. G. Robiette, M.Sc., F.I.M., who is an old student of the College. The medal is to be awarded annually to the best student in the graduating year of the Department of Metallurgy.

Student's Essay

B8

THE CHARACTERISTICS OF THE MARTENSITE TRANSFORMATION *

By DEREK HULL,† B.Sc., Student Member

SYNOPSIS : After a brief historical survey, an attempt is made to define the martensite transformation in terms of its diffusionless characteristics. The validity of this definition is discussed in relation to the known characteristics of the transformation under four headings : (1) diffusionless characteristics, (2) crystallographic characteristics, (3) strain characteristics, and (4) other characteristics.

Introduction

The term " martensite " was proposed in 1895 by Osmond [1] in honour of the German metallurgist A. Martens, and at that time it was used to designate the constituent or structure found in hardened steel. More generally, martensite was found to be formed by rapid cooling from the austenite range to room temperature. Since this early work, the term has found a much wider application. It was observed that a reaction of a similar type to that producing martensite in steel occurred in many other alloy systems, and this led to the use of the term " martensite transformation ". Many characteristics are now associated with the transformation, and these have been gathered together in a number of recent papers. No writer has, however, attempted to formulate a definition for the martensite transformation. In this essay a definition is proposed, and its validity is discussed in relation to the known characteristics.

History in Brief

It is an advantage to include a short history of the development of the idea of a martensite transformation, because this will serve as a background to a more concise formulation of its characteristics. For 43 years after Martens' work, " martensite " referred only to a type of transformation observed in iron-base alloys. Extensive research was carried out on the transformation of austenite in these alloys on rapid cooling.

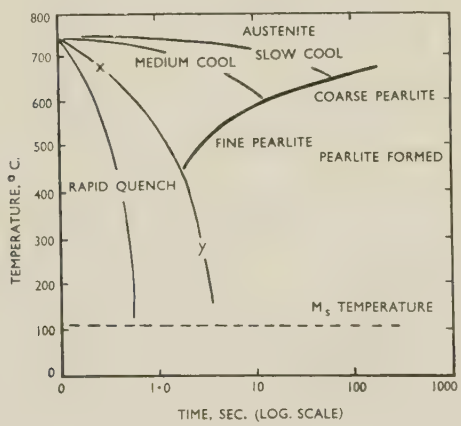


Fig. 1.—Effect of Rate of Cooling on the Decomposition of Austenite into Pearlite and Martensite.

Some important results on the nature of the transformation of austenite to martensite were reported in 1919 by Portevin and Garvin.[2] They discovered a discontinuity at a critical rate of cooling during the thermal analysis of steel specimens. With a sufficiently rapid cooling rate the Ar_1 point was eliminated, and another arrest at a much lower temperature, termed the Ar'' point, was found to be associated with the onset of the formation of martensite. In this connection more recent studies have shown that this work is substantially correct. Curves of the type shown in Fig. 1 have been plotted which represent the effect of rate of cooling on the temperature of the arrest points in steel specimens below the Ar_1 point. On slow cooling the austenite transforms into pearlite, but at a critical rate of cooling, given by the line xy, the breakdown is suppressed and martensite is formed at a much lower temperature. The M_s temperature represents the start of the martensite transformation during continuous cooling, and is the same as the Ar'' point. Portevin and Garvin concluded that the formation of the characteristic needle-like structure is accompanied by an energy change.

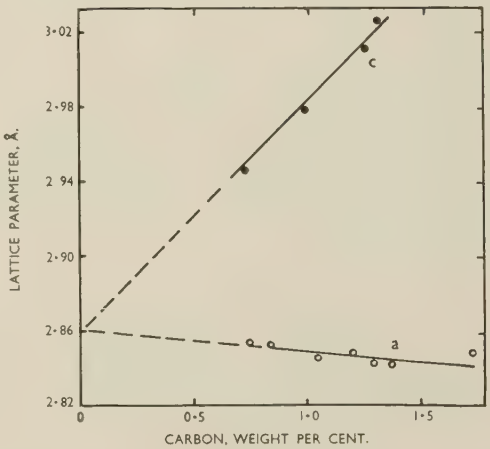


Fig. 2.—The Variation of c and a with Carbon Content in the Body-Centred Tetragonal Cell of Iron–Carbon Martensite. (*After Öhman.*)

The advent of X-ray techniques for the study of crystal structures indicated that martensite had a body-centred tetragonal structure and not a body-centred cubic one as previously supposed. Öhman [3] found that in plain carbon steels the values of c, a, and c/a for the tetragonal cell varied

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linearly with the carbon content (Fig. 2). The formation of martensite in iron–carbon alloys thus involves a transformation or change of lattice type from face-centred cubic austenite to body-centred tetragonal martensite. The full crystallographic nature of the transformation has not been solved, although numerous suggestions have been made. An early theory of transformation suggested by Bain [4] in 1924 assumed from the start that the atoms moved only very short distances. He pointed out that the face-centred cubic structure may be considered as a body-centred tetragonal structure with an axial ratio c/a of 1·414. The transformation was assumed to involve a compression along the c-axis to change the axial ratio of the body-centred tetragonal structure to the axial ratio of martensite (Fig. 3). Although this proposal has since

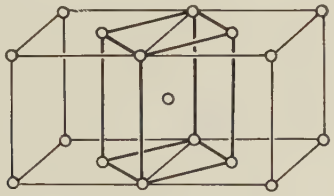

FIG. 3 (*a*).—Two Face-Centred Cubic Cells, Showing the Position of a Body-Centred Tetragonal Cell.

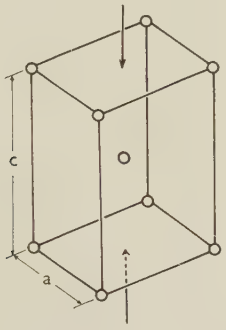

FIG. 3 (*b*).—A Body-Centred Tetragonal Cell Showing the Direction of the Compression Postulated by Bain.[4] The c/a ratio changes from 1·414 to the c/a ratio of martensite.

been shown to be inadequate, it is interesting to note that all the present theories assume only very small atom movements during the transformation. Bain's work was followed by theories from Kurdjumow and Sachs,[5] who studied the crystallography of the transformation in iron–carbon martensite, and from Nishiyama,[6] who worked with iron–nickel alloys in which the transformation is from a face-centred cubic to a body-centred cubic structure.

By 1938 a number of characteristics had been associated with the formation of martensite in steel. These are summarized below from Carpenter and Robertson's book: [7]

(1) The transformation cannot be suppressed by cooling at different rates, and the onset of the transformation takes place at a temperature dependent only on composition.

(2) Transformation occurs only during cooling.

(3) Transformation of some of the austenite retained at room temperature is obtained by deformation.

(4) It is difficult to accept any theory of transformation which assumes diffusion of carbon during transformation. The probable explanation of the transformation is connected with the stresses associated with rapid cooling.

Thus it was realized that the formation of martensite takes place by a different mechanism from that for the formation of pearlite, which was accepted as a nucleation-and-growth process in which the new structure is formed by growth from nuclei at a rate controlled by thermally activated transfer of atoms across the interface.

In 1938 Greninger and Mooradian [8] reported a study of the transformation of metastable β-brass containing 60·8% copper and 39·2% zinc. They examined the structure obtained by quenching this brass into liquid oxygen, and, with a low-temperature microscope stage, the following features were observed:

(*a*) Markings appeared across the grains in the form of needles or fine plates.

(*b*) Markings formed only when the specimen was cooling.

(*c*) Markings formed only in metastable brass.

(*d*) There was no critical temperature for the formation of markings during cooling.

(*e*) The low-temperature markings were rendered visible by virtue of the relief effect which their formation imparted to the surface of the specimen.

Greninger and Mooradian also observed similar markings in specimens which had been given a slight compression treatment after an ice–caustic soda quench. Isaitschew, Kaminsky, and Kurdjumow [9] pointed out in the discussion to this paper that these phenomena are similar and must be given a common term. "Strain transformation" is not really suitable, and they suggested "martensite transformation", because the low-temperature quench leads to the appearance of many of the characteristics observed in the martensite reaction in steel. The close similarity is readily appreciated by a comparison of the two lists given above.

The "martensite transformation" is now generally accepted as a particular type of transformation, and may be contrasted with the well-known nucleation-and-growth transformation. The martensite transformation has been found in many alloy systems and also in pure metals.

Definition of the Martensite Transformation

None of the recent writers on the martensite transformation has attempted to give a full definition of a martensite reaction. The present attitude may be summed up in the words of Bowles and Barrett: [10] "The most appropriate definition and name for the transformation awaits a more complete understanding of the transformation mechanism." Cohen [11] states that: "Martensite is best defined not by what it is but by how it forms, i.e. martensite is a structure that is produced by a martensite transformation. The nature of the reaction must then be given by describing in full the characteristics which are associated with reactions of the martensite type."

This method of definition is least likely to result in misunderstanding, but there are many advantages in a concise definition, which, although it may not cover all the associated phenomena, as a list of characteristics does, is sufficient to differentiate the transformation from any other form of transformation. On this basis, and realizing the incompleteness of present knowledge, a possible definition will be given, and then a discussion will follow on its validity in respect to the characteristics listed in recent papers by Troiano and Greninger,[12] Cohen,[11] and Bowles and Barrett.[10]

> *Definition.*—A martensite reaction is a transformation in the solid state, from one lattice type to another, resulting from atom movements so regular that they produce a change of shape of the transforming region but during which no atomic diffusion occurs.

It is assumed that the possible mechanisms of diffusion in solids are those recorded by Seitz,[13] which are illustrated in Fig. 4. Thus, by the above definition, in a martensite transformation atoms must not move more than one atomic radius relative to adjoining atoms.

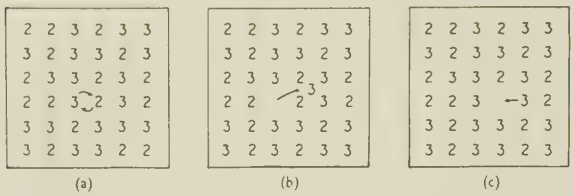

FIG. 4.—Diagrammatic Illustration of the Three Mechanisms of Diffusion in Metals. (*a*) Interchange of atoms in substitutional alloys. (*b*) Interstitial diffusion. (*c*) Movement of vacant lattice sites.

Characteristics of the Martensite Transformation

(a) *Diffusionless Characteristics*

The diffusionless nature of the transformation was realized early in the history of the process, and it is now a well-established fact that the atoms are not displaced in any movement greater than one atomic radius relative to adjoining atoms. This is true even for the relatively rapid-moving interstitial atoms of carbon in steel transformations. There is a large amount of evidence to support the diffusionless nature of the change.

The activation energy for the unit process is very small compared with the activation energy for diffusion at the same temperature. This is suggested by four principal observations: (1) The martensite transformation is not accompanied by any change in composition, as there is no need for long-range diffusion. This may be shown in steels by determining the lattice parameter of the transformation product by X-ray measurements and comparing it with the lattice parameter estimated from the carbon content of the specimen, assuming that in the martensite formed the carbon atoms occupy the sites proposed by Petch.[14] The lattice parameter determined by the two methods is identical, indicating that there is no change in composition. (2) Martensite plates form with extreme rapidity even at temperatures at which the thermally activated movement of atoms within the lattice is slow. Förster and Scheil[15] have reported times for transformation of the order of 1×10^{-4} sec. for zirconium and a 71 : 29 iron–nickel alloy. In many cases the transformation is accompanied by an audible click, and this has been reported[16] even at temperatures near 4° K. (3) Martensite transformations do not proceed at constant temperature as thermally activated processes do, but cease when cooling is arrested. This is not strictly true. In many cases a small isothermal change has been observed, e.g. in Cohen's work with iron–carbon alloys.[17] Recently Cech and Hollomon[18] reported an isothermal martensitic transformation in an iron–nickel–manganese alloy. They state that the transformation proceeds by isothermal nucleation and rapid growth of martensite plates so that the rate-limiting process is nucleation. (4) Martensite formation cannot be suppressed by rapid cooling. In 1942 Greninger[19] devised special apparatus for very rapid gas-quenching and obtained rates as high as 3600° C./sec. No change in the M_s temperature was observed. Recent work by Cottrell[20] indicates that there is a small variation of M_s with rate of cooling for a $3\frac{1}{2}\%$ nickel–chromium–molybdenum steel.

If the parent solid solution contains an ordered arrangement of atoms, the martensite solution inherits the ordered state. This was shown by Kurdjumow[21] for copper–aluminium alloys. Moreover, if the reverse transformation occurs on heating, the regenerated parent solution is still ordered. A similar effect occurs in the interstitial solid solution of carbon in iron which is discussed below, except that the reverse transformation does not occur because the martensite formed rapidly stabilizes.

In the body-centred tetragonal lattice of martensite in steel it has been shown by Petch[14] that the interstitial carbon atoms occupy the centres of the two square faces and the (equivalent) mid-points of the four longer edges (Fig. 5). This distorts the body-centred cubic ferrite into body-centred tetragonal. However, unless the reaction is diffusionless, the carbon atoms could quite as easily occupy all the other interstitial sites of the same type (Fig. 5 (*a*)). If the sites are occupied at random by the carbon atoms, the martensite structure would not be body-centred tetragonal but body-centred cubic α-iron. Hence the carbon atoms within a single plate must be confined to one of the three sets of possible positions in order to account for the observed tetragonality. It turns out that any one of

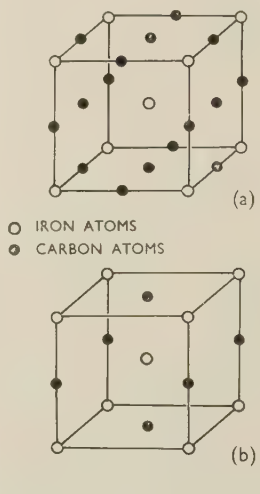

FIG. 5.—(*a*) The Possible Sites for Carbon Atoms in the Body-Centred Cubic Iron Lattice. (*b*) The Carbon Sites to Give a Body-Centred Tetragonal Distortion in the Iron Lattice. (*After Petch.*)

these arrangements is obtained if the carbon atoms do not escape from their original sites in the parent lattice. This is illustrated in full in Fig. 6, assuming that the martensite reaction is a distortion of a body-centred tetragonal arrangement in the austenite to body-centred tetragonal martensite. The planes marked out by the dotted lines are equivalent planes in the two lattices. Thus, despite the high diffusivity of interstitial carbon atoms, they are not able to move independently of the overall shear mechanism during the time of martensite formation.

(b) *Crystallographic Characteristics*

A number of facts about the crystallography of the transformation support the definition. There is always a unique relationship between the lattice of the martensite and the lattice of the parent phase. Each martensite plate is a single crystal whose lattice orientation is strictly determined by the lattice orientation of the parent phase. Usually there is a plane and direction in the martensite crystal that lies parallel

to a somewhat similar plane and direction in the parent crystal; e.g. Troiano and Tokich [22] report that in the trans-

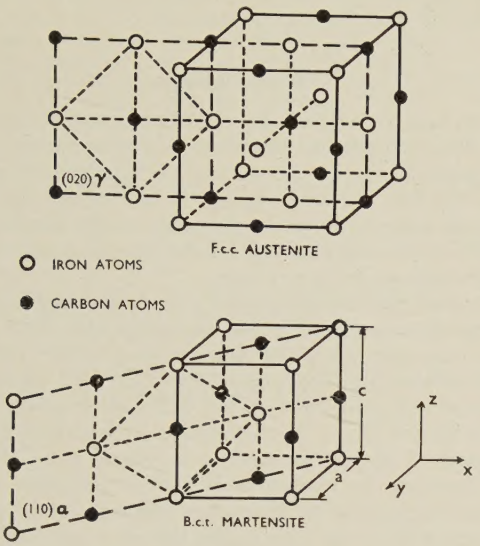

FIG. 6.—Sites of Carbon Atoms in Face-Centred Cubic Austenite and Body-Centred Tetragonal Martensite. The martensite (110) plane is equivalent to the (020) plane of austenite.

formation of cobalt from β (f.c.c.) to α (h.c.p.), the following relationships hold:

$$\{111\}_\beta \parallel \{00.1\}_\alpha$$
$$\langle 110\rangle_\beta \parallel \langle 11.0\rangle_\alpha$$

Complete lists of lattice relationships have been given in the summaries.[10–12]

The physical plane of the martensite plate always has a definite orientation with respect to the parent phase. The crystallographic plane in the parent lattice which lies parallel to the physical plane of the martensite plate is called the "habit" plane. Full details have been tabulated elsewhere.[10–12] The habit plane may change with composition,

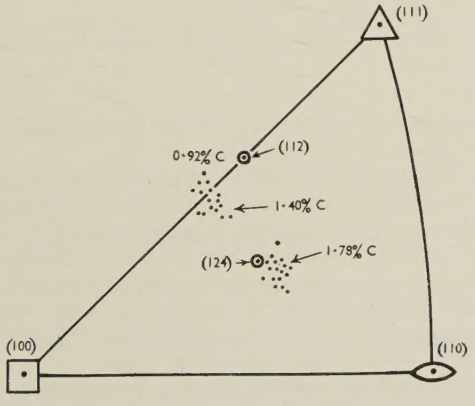

FIG. 7.—The Variation of the Martensite Habit Plane with Carbon Content Shown by a Stereographic Projection of the Poles of the Planes. (*After Greninger and Troiano.*)

as it does in plain steels. The variation of habit plane with carbon content is illustrated in Fig. 7, which is taken from work by Greninger and Troiano.[23] The diagram is a unit triangle of a standard stereographic projection. The corners of the triangle represent the poles of the (111), (110), and (100) planes. Any point within the triangle represents the pole of a plane, and the (112) and (124) poles are marked. For a 1·78% carbon steel, the habit plane lies close to the (124) pole, and for a 0·92% carbon steel it is approximately midway between the (111) and the (100) planes.

It has been mentioned above that martensite forms mainly during cooling and that very little isothermal transformation has been observed. On heating it is found that the reverse reaction takes place, provided that no other transformation occurs, and the crystal structure of the parent phase is not affected by the process of appearance and disappearance of the martensite. Audible clicks can be detected during the heating and cooling reactions in lithium–magnesium alloys.[24] Indirectly, this reversibility gives strong support to the proposed diffusionless nature of the transformation, since it is difficult to conceive of any mechanism involving diffusion which is so perfectly reversible.

If a polished surface is prepared on a sample of the parent phase, the transformation produces characteristic upheavals of the polished surface which effectively render the martensite phase visible. This is well shown by Fig. 8, prepared by the author, of a sample of brass containing 61·0% copper and 39·0% zinc, quenched from 835° C. and then cooled to —55° C.

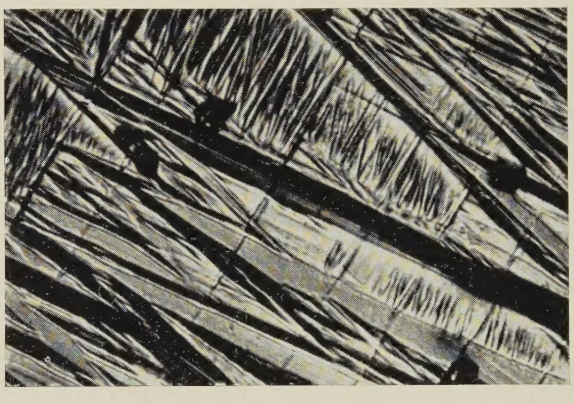

FIG. 8.—61% Copper–39% Zinc Alloy, Quenched from 835° C. and Cooled to —55° C. Relief effects produced on transformation of the β phase. The dark spots are ice crystals. ×200.

The transformation is accompanied by a change in shape of the transformed volume, and it is this change of shape that is responsible for the observed relief effects. The structure shown in Fig. 8 disappears on heating to room temperature, thus indicating that the transformation is reversible.

From these characteristics it may be stated that since there are definite crystallographic relationships between transformed and untransformed regions and since surface upheavals have been observed, there is a change of shape of the parent lattice resulting most probably from a shear mechanism.

(c) *Strain Characteristics*

There are certain characteristics connected with the effect of strain on the parent phase which will be mentioned, since they indirectly support the diffusionless characteristics.

Plastic deformation is effective in forming martensite above the M_s temperature, provided that the temperature does not exceed a critical value (M_d). This readily explains the strain-hardening of such iron alloys as 18 : 8 nickel–chromium stainless steel and Hadfield's manganese steel, which are austenitic

at room temperature. Some martensitic structures may be transformed to another martensitic structure by plastic deformation.[25, 26] The crystal structure of strain-induced martensite is not necessarily the same as that of the martensite which forms spontaneously during cooling in the same specimen. Two different martensitic phases may co-exist in an alloy, as in copper–aluminium alloys.

(d) *Other Characteristics*

For completeness three other characteristics must be mentioned. They are concerned mainly with the kinetics of transformation. They will not be described in full because they are not important for the purpose of this essay.

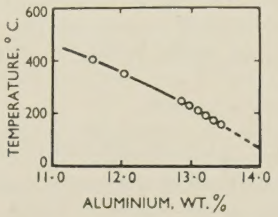

FIG. 9.—The Effect of Aluminium Content on the M_s Temperature for Copper–Aluminium Alloys.

The M_s temperature depends on the composition of the alloy, and for steel alloy systems special empirical equations have been derived to give the M_s temperature in terms of the composition. In a two-phase alloy, the M_s temperature is found to vary regularly with the amount of the constituents. This is illustrated in Fig. 9 for copper–aluminium alloys.[27] The M_s temperature also depends on the grain-size of the parent phase, and may depend on the soaking temperature before quenching. There is not a straight-line relationship between the percentage martensite and the temperature below the M_s point. A typical curve is shown in Fig. 10. However, for one particular alloy, the curve is found to be independent of other possible variables, providing the cooling is continuous. Interruption of cooling causes a stabilization of part of the remaining parent phase and further cooling does not immediately result in further transformation. The magnitude of the stabilization increases with time and temperature of ageing before the cooling is continued. There is also a tendency for stabilization to take place during cooling, and thus the rate of cooling through the martensite range affects the final amount of retained parent phase.

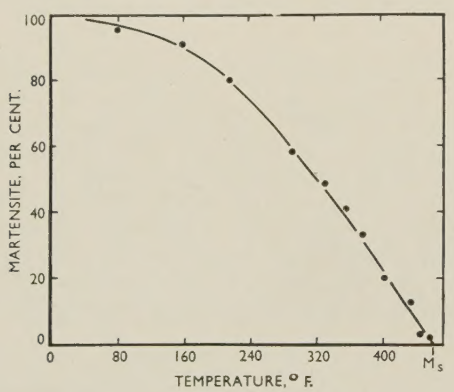

FIG. 10.—Relation Between the Amount of Martensite Formed and the Temperature Below M_s for a 1·1% Carbon, 2·8% Chromium Steel. Austenizing Temperature = 1550° F. (845° C.).

Conclusions

It has been shown that the term " martensite " has found a much wider application than formerly during the last 15 years. Undoubtedly the transformation of austenite in iron-base alloys has been the most extensively investigated transformation, and hence the knowledge gained of this transformation should form an important part in the generalizations regarding transformations in other systems.

The martensite transformation is far from being completely understood, even in the best-known iron-base alloys. Many of the characteristics of the transformation as they are known at the present time have been given, and it is obvious that the most important class is the diffusionless characteristics. Geisler [28] states that: " Perhaps the unique feature of the transformation is that a new structure is formed in a " diffusionless " manner; the reaction occurs under conditions in which chemical segregation by long-range diffusion in solid solutions does not occur or in pure metals diffusion need not occur." The strain and crystallographic characteristics listed suggest indirectly that the diffusionless nature of the transformation must be included in any definition.

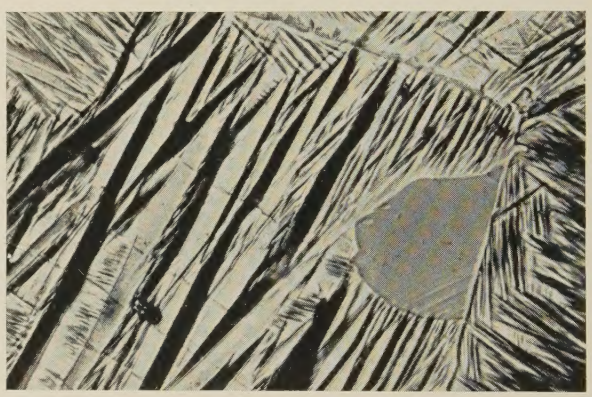

FIG. 11.—61% Copper–39% Zinc Alloy, Quenched from 835° C. and Cooled to —55° C. Martensite structure formed round α'. × 200.

If, as seems likely, the diffusionless nature is unique, then it will be a sufficient criterion for differentiating the martensite transformation from any other transformation. To illustrate this conclusion the transformation of metastable β-brass may be described. For a 61 : 39 brass, quenched in 10% caustic soda from the β range, the β is almost completely retained at room temperature. A small amount, however, may transform into a face-centred cubic structure α' similar to the α phase. The amount of this second phase is greater when slower cooling rates are used, but it is not formed in the same way as the usual precipitation of α from β. Fig. 11 shows the α' phase, along with the martensitic structure, formed on sub-zero cooling. Whereas the martensitic phase has a coherent interface with the β matrix, the α' presumably has an incoherent interface and is formed by thermally activated movement of atoms across this interface, i.e. diffusion occurs during formation.

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By J. Sykes, F.I.M. (*Enfield Copper Refining Co., Ltd.*)

The Control of Quality in the Casting of Zinc and Zinc Alloy Rolling Slabs and Extrusion Billets.
By C. W. Roberts, B.Sc., A.I.M. and B. Walters, M.A. (*Imperial Smelting Corporation, Ltd.*)

The Control of Quality in the Melting and Casting of Aluminium Alloys for Working.
By R. T. Staples and H. J. Hurst (*T. I. Aluminium, Ltd.*)

The Control of Quality in Melting and Casting Magnesium Alloys for Hot Working.
By R. G. Wilkinson, B.Sc. and S. B. Hirst, B.Sc.Tech. (*Magnesium Elektron, Ltd.*)

General Discussion and Indexes.

INSTITUTE OF METALS · 4 Grosvenor Gardens, London, S.W.1

APPOINTMENTS VACANT

A CHEMIST AND A METALLURGIST are required by the British Thomson-Houston Company at their research Laboratories in Rugby for fundamental research on new high-temperature materials with special reference to metallic borides and silicides. Both should be graduates with a good honours degree, preferably with research experience. Apply quoting reference "BS", and stating age, qualifications, and experience to the Director of Research, The British Thomson-Houston Co., Ltd., Rugby.

A PHYSICAL METALLURGIST is required for work in the research laboratory of the British Thomson-Houston Company for fundamental work on the strength of pure metals. Candidates should have a good honours degree in physics or in metallurgy and preferably two or three years' research experience. Apply, quoting reference "PM", and stating age and qualifications and experience to: Director of Research, The British Thomson-Houston Co., Ltd., Rugby.

G.K.N. GROUP RESEARCH LABORATORY requires a metallurgist to be responsible for development work in connection with precision casting. Some experience in this field is essential, and preference will be given to candidates holding a degree or equivalent qualification. Applications should be made to Director of Research, G.K.N. Group Research Laboratory, Birmingham New Road, Lanesfield, Wolverhampton.

METALLURGIST (experienced) required for Research Department. Personality, ability to control Inspection Section, and sound qualifications are essential. Superannuation scheme. Address applications in writing, stating age, qualifications, and experience, to Personnel Manager, Magnesium Elektron, Ltd., Clifton Junction, near Manchester.

METALLURGIST required for research and development work on magnesium alloys. Applicants should possess an honours degree in metallurgy or chemistry, or A.I.M. or A.R.I.C. Initiative and ability to work with minimum supervision are essential, and experience of corrosion testing or related work would be an advantage. Address applications in writing quoting ref.: J.I.M.S.M. 13, and stating age, qualifications, and experience to Personnel Manager, Magnesium Elektron, Ltd., Clifton Junction, near Manchester.

METALLURGIST required for research and development work on the production of magnesium alloy castings. Applicants should possess honours degree in Metallurgy or A.I.M. Initiative, ability to work with minimum supervision, and experience in casting technology essential. Address applications in writing, quoting ref.: J.I.M.M. 13, and stating age, qualifications, and experience to Personnel Manager, Magnesium Elektron, Ltd., Clifton Junction, near Manchester.

METALS DIVISION of the Osram-G.E.C. Lamp Works, require metallurgical chemists for the technical control and development of rare and refractory metals. Work includes chemical extraction and mechanical working processes requiring use of highly specialized techniques. Senior appointment calls for B.Sc.(Met.) or equivalent—junior up to H.N.C. standard. Apply Personnel Department, Osram-G.E.C., Lamp Works, East Lane, North Wembley, Middlesex.

METALS RESEARCH. The Mond Nickel Co., Ltd., has several vacancies in its Birmingham laboratory for men with good honours degrees to work on the physical metallurgy of (*a*) alloy steels and cast irons, (*b*) high-temperature materials, and (*c*) corrosion-resistant materials. Previous Works or laboratory experience desirable but not essential. Apply, stating age, qualifications, experience, salary required, &c. to Manager, Development and Research Department. The Mond Nickel Co., Ltd., Sunderland House Curzon Street, London, W.1. Mark envelope "Confidential L. 19."

METROPOLITAN-VICKERS ELECTRICAL CO., LTD., Trafford Park, Manchester 17, has a vacancy for an assistant spectrographer in the metallurgical laboratory. Applicants should have B.Sc. and be interested in spectrographic techniques. Previous spectrographic or metallurgical experience an advantage. Salary, according to age, qualifications, and experience, will be progressive. Write to the Personnel Manager, giving full particulars, including age, sex, nationality, education, and experience.

MINISTRY OF SUPPLY requires Metallurgists for Experimental Establishments in South of England for research and development work chiefly on corrosion, fatigue, high-temperature materials, and light-alloy technology. Appointments according to qualifications and experience: (Ref. F29/54A) ASSISTANT EXPERIMENTAL OFFICER, £276 (age 18)—£615; EXPERIMENTAL OFFICER, £690–£850—both requiring Higher School Cert. (Science) or equivalent, although further training to standard of H.N.C., A.I.M., &c., may be an advantage—or (Ref. F30/54A) SCIENTIFIC OFFICER, £445–£815—requiring 1st or 2nd class honours degree in metallurgy, or in physics or chemistry with bias to metallurgy. All appointments unestablished. Women's rates somewhat less. F.S.S.U. benefits may be available for S.O.s. Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate reference.

QUALIFIED PRACTICAL METALLURGIST required, with a good non-ferrous foundry experience, and ability to control the mixing, melting, and casting of metals. Write stating age, experience, and qualifications to the Works Controller, The Anti-Attrition Metal Co., Ltd., Woodlands Park, Maidenhead, Berks.

RESEARCH APPOINTMENTS in laboratories in Cambridge are vacant in the fields of electron microscopy and diffraction, including latest techniques of reflection electron microscopy, for research and development in problems of solid-state and surface physics, metallurgy, and surface chemistry. Salary according to qualifications and experience £400–£800 p.a. Box No. 366, The Institute of Metals, 4 Grosvenor Gardens, London, S.W.1.

THE RESEARCH DEPARTMENT of the Metals Division of Imperial Chemical Industries, Ltd., requires a physicist or physical metallurgist with research experience and well conversant with current views on alloy theory, to undertake experimental work intended to provide the fundamental background to the alloying behaviour of TITANIUM. Salary will be dependent on qualifications and experience, but will be up to a maximum of £1200 per annum. Application forms may be obtained from Assistant Staff Manager, I.C.I. Metals Division, Kynoch Works, Witton, Birmingham 6.

THE UNIVERSITY OF LEEDS. Applications are invited for two posts in Metallurgy, each of which may be *either* on the Lecturer scale (£550 × £50–£1,100) *or* on the Assistant Lecturer scale (£500 × £25–£550), from candidates well qualified in Metallurgy, Physics, or Physical Chemistry. For one post, experience in physical metallurgy or solid-state physics is desirable, while the work of the other post initially will be on the kinetics and thermodynamics of metal-extraction reactions. Applications (three copies) stating date of birth, qualifications, and experience, together with the names of three references, should reach the Registrar, The University, Leeds 2 (from whom further particulars may be obtained) not later than 15 July 1954.

YOUNG METALLURGICAL GRADUATE required in the Research Department. The post involves interesting duties in connection with the investigation of works processes in the production of carbon and alloy steels. A knowledge of statistics would be an advantage. Written applications, with full details of training and experience to date, should be addressed to The Personnel Manager, Hadfields Ltd., East Hecla Works, Vulcan Road, Sheffield, 9.